This would give a proportionate amount of—

Felspar, 2·1; Quartz, 1·6; RO Minerals, 1.

This shows that such a compound as the above might, in consolidation, crystallise in the form of one of the rocks belonging to the Noyang group; and a compound formed by the fusion of different proportions of the igneous magma and the sediments might produce any one of them.

Such fusions have taken place in the Gippsland area, at the close of the Silurian age, to an enormous extent, and the influence of the absorbed sediments on the invading igneous magmas cannot be overlooked.

It seems to me that such possibilities, in the formation of igneous rocks, have not yet been sufficiently regarded by petrologists.

Art. V.—*On the Occurrence of Bacteria (Bacilli) in Living Plants.*

By T. S. Ralph, Esq.

[Read 10th May, 1883.]

In these days of germ-theory and of research after bacteria discoverable in the tissues of animals, and supposed to be elements of disease in some form or condition, and when we are called on to become familiar with such terms as these—Sphæro-bacteria, Micro-bacteria, Desmo-bacteria, Filo-bacteria, and Spiro-bacteria, Bacilli and Micro-cocci; and then some of their results, as Bacteruria and Pathogenous-bacteria, in relation to a whole host of maladies, and the question of mutability of bacteria, it may not be without interest to bring before the notice of the scientific mind that bacillus (a sub-genus of bacterium) is to be detected in living plants.

A few years ago there was a notice in the *Journal* of the Royal Microscopical Society of England to this effect, that bacteria had been found in the crushed tissues or cells of plants; and the question was asked, as this had been noticed

by some foreign observers, Have any investigators in England observed, or encountered, the same objects ?

To this day, so far as I have been able to ascertain, no further information has been accorded, save that bacilli have been noticed in the tissues of decaying or dying plants in a moist condition, leading us to suppose that these organisms may be direct promoters of the decay of such vegetals.

The interesting part of my communication lies in this: that living bacilli can be shown in the living cells of what appears to be a healthy vallisneria, and I have also found them in the cells of another water-weed—*i.e.*, *Anacharis alsinastrum.*

As far as I have been able to ascertain, these organisms (bacilli) can be readily detected in the square cells of the surface of the leaf, intermixed with chlorophyl grains, but soon gravitating to the lower portion of each cell. They appear to be confined to these superficial cells, and are with difficulty to be traced in the deeper-seated larger ones of the plant. On two occasions I have distinctly seen a bacillus occupying the central portion of a large cell in which cyclosis was going on. On account of the greater density of the protoplasm moving along the walls of the cell, I suppose the bacillus could not enter the current, the lesser specific gravity of this organism preventing it occupying any portion of the stream which was of greater density than itself, hence its steady continuance in the central or calm region of the cyclosis.

Now come questions:—What relation do these bacilli bear to the host, or plant, in which they are found ? Are they vegetals, living in commensalism with it ? Are these organisms vegetal or animal in their life character ? Do they await the dissolution of the cell contents in order to complete further destructive changes ? Or do they conduce to the fermentative or zymotic change of the chlorophyl and starch grains occupying the cells in which they are found ?

These are not useless questions to be asked ; and, if solved, possibly their solution may tend to explain or set at rest some of the vexed and disputed points which have presented themselves regarding disease germ-cells and their presence in the animal economy.

Although bacteria and bacilli have been familiar to me for some fourteen years, and I have noticed them in animal tissues undergoing decomposition—in the blood of man, in the blood of puerperal cases (certainly, only at times of ill-

conditioned health), in the renal secretion quite recently passed—yet, strange to say, although the cells of vallisneria have been examined by me hundreds of times, the presence of these organisms has hitherto escaped observation, or been overlooked. I account for this from this circumstance —that the bacilli are minute; they occupy, chiefly, external cells; are intermixed with cell contents; and, lastly, they gradually gravitate to the lowest portion of the cell in which they are to be found, so that the examination of a leaf which has been lying for some time flat on the table will fail to afford evidence of their presence, as they have sunk behind or below the starch and chlorophyl grains in the cell.

There is, however, another feature for consideration. The plant on which I have been experimenting—and you have before you specimens of it, and they look healthy—has been under confinement or cultivation for a period of three or four years; and I have also, in examining specimens of leaves living in an open pond, found no bacilli, and we have therefore to consider the conditions of life to which my specimens of vallisneria have been subjected, *i.e.*, in the summer season to a temperature at times, as I have ascertained, of 100 degs. Fahr., and a less depth of water than natural.

The plant as I have seen it in Sydney possessed leaves five to six feet in length, with more than an inch in breadth, and of such thickness that it was easy to cut slices edgeways off it, each slice having an upper or a lower edge of outside cells on the right and left of the observer, so that the central larger cells can be fully exposed for viewing the cyclosis going on in them, besides which it is easy to split the leaf into two layers for the same purpose.

The greater size of the cells and the easy mode of manipulation conduce very favourably to the examination of this phenomenon, compared with the cells of the European variety of this plant, as I pointed out in my recent visit to England, when I introduced a few living specimens of our Australian form for the special benefit of my colleagues in microscope research.

It will be well to pursue the conditions of life which have surrounded my specimens. For instance, the pond plant has a darker area in which it grows; the light supplied to it under natural conditions reaches it mainly from above, whilst lateral supply is materially lessened. Compare,

for instance, this biological condition with that which has obtained with my tank plant. A large glass vase, of less than two feet in depth, and light pouring into it in the open air and surrounding the plant at all angles; and not only so, but a greater variation in the temperature of the water in which it lives, for, I suppose, no pond water would rise 100 degs. Fahr., nor, indeed, over the average temperature of the surrounding earth at a depth of one foot below the surface. The factor of extreme light, with advanced amount of heat, may be an important one in aiding the development or, perhaps, of introducing the bacteria into the system of the plant.

I may add that my plants, with this exception—*i.e.*, the presence of bacilli—appear to be healthy. They throw up male florets and long peduncles of female flowers, and, moreover, are clean-looking compared with their less civilised and favoured fellows of pond-life. These appear to me, to sum up at present, all the known biological conditions.

But, to return, What is the true nature of these organisms?

First of all, it seems to me that we are not dealing with true vegetal forms in some instances, and that there are objects which possibly have been placed in the category of organised life which are really chemical combinations, and not specific plants or animals. Supposing that at this point of the organic world we are able to differentiate between these two forms—animal and vegetal—what functions, however, do these organisms which we have been considering subserve? They are widely spread or distributed, and they lead us to surmise that they tend to the production of further decompositions of the tissues in which they are found. Fermentation of ordinary materials is familiar to us, and here, in some degree, I think we are warranted in accepting their presence as needful to this end. I will adduce another instance of their presence, and also of the mode by which they seem to be brought into activity, and this is in accord with the phenomena of their presence in superheated living specimens of vallisneria, and their comparative, if not their total, absence from those specimens which have not been exposed to superheat or light conditions.

I have found bacteria in abundance in tea leaves after infusion for tea-drinking. Now tea when prepared by the grower is allowed to heat or commence fermentation, and

this process is suddenly arrested by the operator at a certain point, requiring great judgment in its exercise, and the tea leaf is dried, so that the process of fermentation ceases. So their presence seems to have been called forth by the abundant action of heat. I have not been able to examine the tea leaf under natural conditions, in order to ascertain the presence of these bodies ; but in the leaf of a camellia, which is an ally of the tea plant, I have found some bacteria. I have now little doubt that they are largely distributed in the vegetal world. But the evidence afforded us of their presence in the living cells of vallisneria is most satisfactory in this respect; that without manipulation their presence can be determined, and, so far, we are certified that their presence is not the result of outside contamination, as might be urged when they are found in the crushed cells of plants. There is, besides, another point of interest, namely, that ensilage, or the process of forming fodder by subjecting green vegetable matter, as grass and trefoil, &c., to immediate pressure from the field, in order to form it into cattle food, is dependent on the presence of bacteria forms let loose, and that perhaps owing to the facility of these organisms to be let loose may depend the success or failure which attends this newly imported process of fodder preparing.

In conclusion, I have no intention of discrediting the action of bacteria forms as disease germ-cells if regarded as disease promoters through derived chemical poisons. There may be also a question to be settled. Are they different in their organic characters, further than or beyond the inducted poison which they appear capable of transmitting? Their chemical constitution may enable them to present differences in colouring under the use of dyes.

These considerations lead me to think and suggest that we should not dissociate the study of the animal economy from that of the vegetal. In this last we have placed before us the leading physiological phenomena of the organic world to study in their simplest form, and if duly examined and recorded will, I believe, enable us to carry a thread of continuity from the vegetal forms into the animal organic, always, however, remembering that there has been a differentiation in the production of the higher, as compared with the lower, forms of existence.